

First record of an Early Cretaceous theropod dinosaur bone from Western Australia

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To date the only records of dinosaurs from Western Australia have been one possible theropod bone from the Late Cretaceous (Maastrichtian) Miria Formation, south of the Exmouth Gulf, one theropod pedal phalange from the Late Cretaceous (?Turonian–Cenomanian) Molecap Greensand, and a caudal vertebra from a possible sauropod from the Middle Jurassic Colalura Sandstone of the Geraldton region (Long 1992, 1995). The only record of dinosaurs from Early Cretaceous sediments in Western Australia is from footprints preserved in the Berriasian–Valanginian Broome Sandstone exposed in the Broome region and Dampier Peninsula. This assemblage of trackways from Broome indicates a great diversity of dinosaurs existed in Western Australia at this time, ranging from theropods (Colbert and Merrilees 1967), sauropods (Thulborn *et al.* 1994), bipedal ornithischians and a possible stegosaur (Long 1993), but no skeletal remains have been recovered. Here we report the first occurrence of a dinosaur bone of Early Cretaceous age from Western Australia.

The specimen was found by one of us (JL) about 4 metres away from where a partial skeleton of a new species of the pliosaur *Leptocleidus* was found (Cruickshank and Long in press), from the Hauterivian–Barremian Birdrong Sandstone, exposed to the north of Kalbarri. It was lying on the surface scree weathered out from near the top metre of the Birdrong Sandstone, preserved in exactly the same manner as the pliosaur bones recovered from that unit. To date many such bones of pliosaurs and some ichthyosaurs have been found on outcrops of the Birdrong Sandstone, all appear to be coming out of the top metre or so of the unit. The specimen described herein was found in three pieces lying in close association, only a few centimetres apart, which were glued together to show its characteristic vertebral shape.

Description of the specimen

The specimen (WAM 96.5.1, Fig. 1) is a mid caudal vertebra. It differs from the pliosaurid

vertebrae commonly found in the Birdrong Sandstone by its much longer rostrocaudal length, narrower centrum, and its short flattened transverse processes (Fig. 1C, tr.p), and lack of subcentral foramina. The dorsal surface shows the traces of where the posterior zygapophyses were developed (Fig. 1C, po). The bone lacks the neural arch and is missing part of the posterior centrum as well as the distal face of the centrum. The anterior face of the centrum is flat, a characteristic of theropod mid caudal vertebrae, and is much larger than the estimated size of the posterior face of the centrum. In this respect it differs from the caudal vertebrae in hypsilophodontids and basal iguanodontians in general (Galton 1974, Coria and Salgado 1996). Sauropods tend to have long tails and so the mid-distal caudal vertebrae are mostly elongated, amphicoelous, with approximately equal anterior and posterior centrum faces (McIntosh 1990), unlike the Birdrong specimen. Most thyreophorans, or the armoured ankylosaurs and stegosaurs, have specialised tails bearing enlarged clubs, spines or heavy dermal ossicles, and thus the mid caudal vertebrae are more robust with strongly overlapping postzygapophyses (Coombs *et al.* 1990; Coombs and Maryanska 1990).

By comparison with the tail vertebrae of *Allosaurus fragilis* (Madsen 1976) and direct observation of other theropod dinosaur skeletons (e.g., *Gorgosaurus libratus*, W.A. Museum cast; *Tarbosaurus bataar*, Palaeontological Institut, Moscow 551– 4/49) it is most likely from a theropod. It compares very closely in overall proportions with the 37th–40th caudal vertebrae of *Allosaurus fragilis* (Madsen 1976, pl. 35 F,G,) but is about half the size, suggesting that the Birdrong theropod may have been in the order of 5 m maximum length.

Discussion

Early Cretaceous theropods thus far recovered from Australia mostly come from the Albian–Aptian Otway and Strzelecki Groups of Victoria. They include the allosaurid *Allosaurus* sp. (Molnar

et al. 1981, 1985), an ornithomimid, *Timimus hermani* (Rich and Rich 1994), a possible caenagnathid (Currie *et al.* 1996) and isolated teeth and bones of dromaeosaurids (P.V.Rich and T.H.Rich., pers. comm. 1996). Other early Cretaceous Australian theropods are *Kakuru kujani* and other isolated theropod bones from the opal fields of Andamooka, and Coober Pedy, South Australia (Molnar and Pledge 1980) as well as from Lightning Ridge in New South Wales (*Walgettosuchus*, *Rapator*; Long 1993). The Birdrong bone precludes comparison with these forms as all are known from very scant remains, often from only one bone, and all of the above mentioned taxa

do not have the caudal vertebrae preserved (except *Walgettosuchus*, which is undiagnostic as to family, Long 1993). The Birdrong specimen compares well with mid-posterior caudal vertebrae of *Allosaurus fragilis*. The bone probably represents a small tetanuran theropod of indeterminate family.

The specimen demonstrates the further potential for future discoveries of dinosaurs from this unit which outcrops extensively to the north as far as Cardabia Station (McLaughlin *et al.* 1995). To date, wherever the Birdrong Sandstone has been identified, it has yielded abundant fossilised wood and scant marine reptile remains, including the first partially articulated remains of ichthyosaurs from Western Australia, found in the northernmost exposures of the unit, collected by a WA Museum field party in July 1994. Cruickshank and Long (in press) note that the other known occurrences of the pliosaur *Leptocleidus*, which occurs in the Birdrong Sandstone, are always with an associated dinosaur fauna (e.g., eastern Cape Province, South Africa; Wealden Beds, U.K.; Coober Pedy, South Australia), further reinforcing the suggestion that the Birdrong Sandstone has great potential for future dinosaur discoveries.

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REFERENCES

- Colbert, E.H. and Merrilees, D. (1967). Cretaceous dinosaur footprints from Western Australia. *Journal of the Royal Society of Western Australia* 50: 21–25.
- Coombs, W.P. Jr, Weishampel, D.B. and Witmer, L.M. (1990). Basal Thyreophora. In D.W. Weishampel, P. Dodson, P. and H. Osmolska (eds.), *The Dinosauria*: 427–455, University of California Press, Berkeley.
- Coombs, W.P. and Marayanska, T. (1990). Ankylosauria. In D.W. Weishampel, P. Dodson, P. and H. Osmolska (eds), *The Dinosauria*: 456–483, University of California Press, Berkeley.
- Coria, R.A. and Salgado, L. (1996). A basal iguanodontian (Ornithischia: Ornithopoda) from the Late Cretaceous of South America. *Journal of Vertebrate Paleontology* 16: 445–457.
- Cruickshank, A.R.I. and Long, J.A. (in press). A new

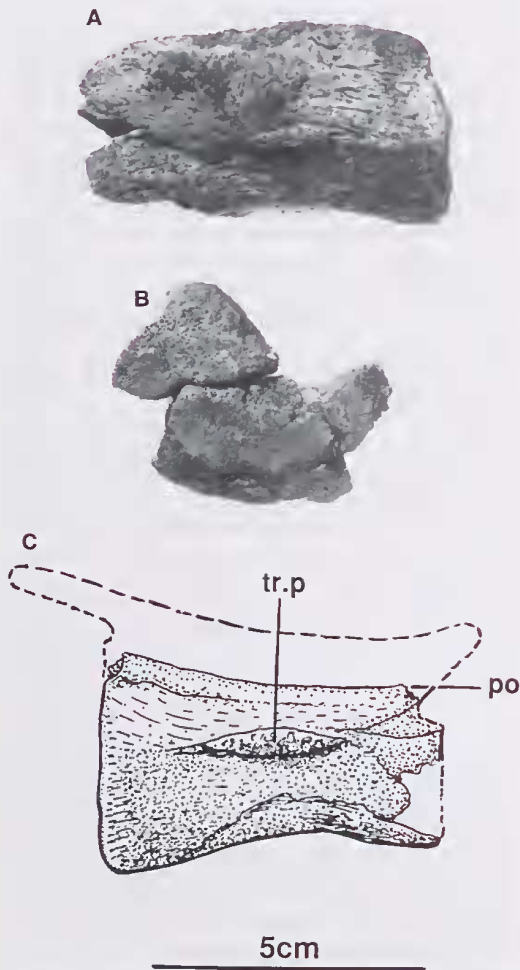


Figure 1 A, theropod mid caudal vertebra seen in right lateral view, and B, anterior view, natural size. C, Sketch of theropod mid caudal vertebra in left lateral view, showing main features, with restoration of suggested outline. Scale bar is 5 cm. Abbreviations: po, basal section of posterior zygapophysis; tr.p, transverse process.

- species of pliosaurid reptile from the Early Cretaceous Birdrong Sandstone of Western Australia. *Records of the Western Australia Museum*.
- Currie, P.J., Vickers-Rich, P. and Rich, T.H. (1996). Possible oviratosaur (Theropoda, Dinosauria) specimens from the Early Cretaceous Otway Group of Dinosaur Cove, Australia. *Alcheringa* 20: 73-79.
- Galton, P.M. (1974). The ornithischian dinosaur *Hypsilophodon* from the Wealden of the Isle of Wight. *Bulletin of the British Museum (Natural History) Geology* 25: 1-152.
- Long, J.A. (1992). First dinosaur bones from Western Australia. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences* 9: 21-28.
- Long, J.A. (1993). *Dinosaurs of Australia, and other animals of the Triassic, Jurassic and Cretaceous Periods*. Reed Book, Sydney.
- Long, J.A. (1995). A theropod dinosaur bone from the Late Cretaceous Molecap Greensand, Western Australia. *Records of the Western Australia Museum* 17: 143-146.
- Long, J.A. and Cruickshank, A.R. (in press). Further records of plesiosaurian reptiles from the Jurassic and Cretaceous Periods of Western Australia. *Records of the Western Australian Museum*.
- McIntosh, J.S. (1990). Sauropoda. In D.W. Weishampel, P. Dodson, P. and H. Osmolska (eds), *The Dinosauria*: 345-401, University of California Press, Berkeley.
- McLaughlin, S., Haig, D.W., Backhouse, J., Holmes, M.A., Ellis, G., Long, J.A. and McNamara, K.J. (1995). Oldest Cretaceous sequence, Giralia Anticline, Carnavon Basin, Western Australia: late Hauterivian-Barremian. *Journal of Australian Geology and Geophysics* 15: 445-468.
- Madsen, J.H. Jr. (1976). *Allosaurus fragilis*: a revised osteology. *Utah Geological and Mineral Survey, Bulletin* 109: 1-163.
- Molnar, R., Flannery, T.F. and Rich, T.H. (1981). An allosaurid theropod dinosaur from the Early Cretaceous of Victoria, Australia. *Alcheringa* 5: 141-146.
- Molnar, R., Flannery, T.F. and Rich, T.H. (1985). Aussie *Allosaurus* after all. *Journal of Paleontology* 59: 1511-1513.
- Molnar, R. and Pledge, N. (1980). A new theropod dinosaur from South Australia. *Alcheringa* 4: 281-287.
- Rich, T.H. and Rich, P.V. (1994). Neoceratopsians and ornithomimosaur: dinosaurs of Gondwana origin? *Research and Exploration* 10: 129-131.
- Thulborn, T., Hamley, T. and Foulkes, P. (1994). Preliminary report on sauropod dinosaur tracks in the Broome Sandstone (Lower Cretaceous) of Western Australia. *Gaia* 10: 85-94.

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